Pump System Design for the EHS and AOSE

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Volumes

- There are 7.48 gallons per cubic foot
- There are 231 cubic inches per gallon

Find the volume of a rectangular tank (given dimensions in feet)

L * W * H

Where L = length (feet), W = width (feet), H = height (feet)

Example: Find the volume of a tank that is 8' long, 4' wide, and 4' high:

8' * 4' * 4' = 128 cubic feet

Convert to gallons:

128 ~~cubic feet~~ * 7.48 gallons ~~per cubic foot~~ = 957.4 gallons

To determine gallons per inch:

957.4 gallons / 48 inches = 19.95 gallons per inch (say 20)

Find the volume of a rectangular tank (given dimensions in inches)

L * W * H

Where L = length (inches), W = width (inches), H = height (inches)

Example: Find the volume of a tank that is 96" long, 48" wide, and 48" high:

96" * 48" * 48" = 221, 184 cubic inches

Convert to gallons:

221,184 ~~cubic inches~~ / 231 ~~cubic inches per~~ gallon = 957.4 gallons

To determine gallons per inch:

957.4 gallons / 48 inches = 19.95 gallons per inch (say 20)

Find the volume of a cylinder (pipe)

If working in feet, determine cubic feet, then convert to gallons:

$\pi r^2 * h$ or $\pi d^2/4 * h$

Where, r = radius (feet) or d = diameter (feet)

h = height (feet)

Example: Find the volume of a pipe that is one foot long with an inside diameter of 2" (actual I.D. = 2.067"):

$\pi d^2/4 * h$ (note: "d" in feet = 2.067/12)

$\pi(2.067/12)^2/4 * 1 = 0.0233$ cubic feet

Convert to gallons:

0.0233 ~~cubic feet~~ * 7.48 gallons ~~per cubic foot~~ = 0.1743 gallons

Find the volume of a cylinder (pipe)

If working in inches, determine cubic inches, then convert to gallons:

$\pi r^2 * h$ or $\pi d^2/4 * h$

Where, r = radius (inches) or d = diameter (inches)

h = height (inches)

Example: Find the volume of a pipe that is one foot long with an inside diameter of 2" (actual I.D. = 2.067"):

$\pi d^2/4 * h$

$\pi(2.067)^2/4 * 12 = 40.267$ cubic inches

Convert to gallons:

40.267 ~~cubic inches~~ / 231 ~~cubic inches per~~ gallon = 0.1743 gallons

Velocities

See Sewage Handling and Disposal Regulations 12 VAC 5-610-880.A.1

The minimum velocity in a force main shall be 2 feet per second (fps).
(To prevent suspended solids from accumulating in low spots).

The maximum velocity in a force main should not exceed 8 feet per second (fps).
(To prevent damage to inside of pipe).

How do you determine if the velocity in the force main is ≥ 2 fps and ≤ 8 fps?

Use Continuity Equation:

$Q = VA$

Where, Q = flow rate (cubic feet per second)
V = velocity of flow (feet per second)
A = area of pipe diameter (square feet)

Conversion:

GPM = (cubic feet per second) (448.8)
Note: 448.8 comes from: (7.48 gal/ft^3) (60 sec/min)

Example #1: Determine the minimum GPM required to obtain 2 fps in a 2" (2.067") diameter pipe:
$Q = VA$
Step 1: $V = 2$ fps
Step 2: Calculate "A"
$A = \pi d^2/4$ (could also use πr^2)
$A = \pi(2.067/12)^2/4$ (Note: 2.067 was divided by 12 to keep units in feet)
$A = 0.0233$ square feet
Step 3: Calculate "Q"
$Q = (2 \text{ fps})(0.0233 \text{ ft}^2) = 0.0466 \text{ ft}^3/\text{sec}$
Convert ft^3/sec to gpm:
$Q (\text{gpm}) = (0.0466 \cancel{\text{ft}^3}/\cancel{\text{sec}}) (7.48 \text{ gal}/\cancel{\text{ft3}}) (60 \cancel{\text{sec}}/\text{min}) = 20.91$ gpm (say 21 gpm)
Note: 21 gpm in a 2" force main is equivalent to a velocity of 2 feet per second
Therefore, 84 gpm is equivalent to 8 feet per second.

Example #2: The flow rate through a 2" (2.067") force main is 36 GPM.
What is the velocity in feet per second?
Step 1: Rewrite the equation to solve for V.
$V = Q/A$
Step 2: Convert 36 GPM to cubic feet per second
$Q = 36 \text{ GPM} / 448.8 = 0.0802$ cubic feet per second
Step 3: Calculate "A"
$A = \pi d^2/4$
$A = \pi(2.067/12)^2/4$
$A = 0.0233$ square feet
Step 4: $V = 0.0802$ cubic feet per second / 0.0233 square feet = 3.44 fps

Example #3: Determine the minimum GPM required to obtain 2 fps in a 3" (3.068") diameter pipe:
$Q = VA$
$V = 2$ feet per second
$A = \pi(3.068/12)^2/4 = 0.05134$ square feet
$Q = (2 \text{ fps})(0.05134 \text{ ft}^2) = 0.1027$ cubic feet per second
Convert cubic feet per second (ft^3/sec) to gpm:
$Q (\text{gpm}) = (0.1027 \cancel{\text{ft}^3}/\cancel{\text{sec}}) (7.48 \text{ gal}/\cancel{\text{ft}^3}) (60 \cancel{\text{sec}}/\text{min}) = 46.1$ gpm

Dosing Volumes and Pumping Capacity

The pump cycle dose or drawdown (i.e. how much effluent is pumped to the drainfield each time the pump cycles) and the pumping capacity (i.e. the rate at which effluent is pumped to the drainfield in gallons per minute) are determined based on the objective of pumping. When pumping to a distribution box the objective may be 1) to overcome elevation, or 2) for the purpose of enhanced flow distribution.

1. Pumping to a distribution box to **overcome elevation**:

   "*When the ground surface in the area over the absorption trenches is at a higher elevation than any plumbing fixture or fixtures, sewage from the plumbing fixture or fixtures shall be pumped*". (See 12 VAC 5-610-950.H.2)

A. **Dosing Volume = between 1/4 the design daily flow and the design daily flow**
(see 12 VAC 5-610-880.B.1)

Example: What is an acceptable dosing volume for a 4 bedroom dwelling with a design flow of 600 gpd?
Answer: The design daily flow is 600 gallons and 1/4 the design daily flow is 150 gallons. Therefore, you could design your system to dose any where from 150 to 600 gallons per dose.
Note: Most designers specify a dose based on enhanced flow distribution (see next page).

B. **Pumping Capacity**:

12 VAC 5-610-880.B.6 states that the pump "*shall have a capacity approximately 2.5 times the average daily flow in gallons per minute but not less than five gallons per minute at the system head*". This requirement assures that the pump can keep up with peak flows. Chances are that other sections of the regulations will require a greater pumping rate than what is specified under section 880.B.6.

12 VAC 5-610-880.A.1 states that the minimum pumping rate must be sufficient to provide 2 feet per second in the force main. This was covered on the previous page of this handout (see Velocities). Therefore, **the minimum pumping rate for most situations where the purpose of pumping is to overcome elevation is controlled by the size of the force main used**. Two feet per second in various pipe size diameters is as follows:

1 1/2" pipe	2 fps = 12.7 gpm
2" pipe	**2 fps = 20.9 gpm**
3" pipe	2 fps = 46.1 gpm
4" pipe	2 fps = 79.4 gpm

In most single family applications, a 2" force main is used. Therefore, the **minimum pumping rate** when using a **2" force main** for the purpose of **overcoming elevation is 21 gallons per minute.**

Dosing Volumes and Pumping Capacity (continued)

2. Pumping for the purpose of **enhanced flow distribution**:

Why would you need enhanced flow distribution? There are many reasons.

* The flow is split **more than** 12 times
* The system contains more than 1200 linear feet of percolation piping
* To reduce the setback to a stream from 50' to 20' (texture I & II soils) or 10' (texture III & IV soils)
* To reduce the setback to a drainage ditch (where the ditch bottom is below the seasonal water table and the ditch normally contains water) from 70' to 20' in texture I & II soils or from 50' to 10' in texture III & IV soils (see Sewage Handling and Disposal Regulations, Table 4.2).

A. **Dosing Volume = 60% of the volume of the percolation piping**:

A one foot length of 4" pipe that is 60% full contains 0.39 gallons:

$(\pi r^2 h)\,(7.48)\,(0.6) = 0.39$

where,

π	=	3.14
r	=	2", but must be expressed in feet (2/12 = 0.167)
h	=	1 foot length of 4" diameter pipe
7.48	=	the number of gallons in one cubic foot
0.6	=	60% of the volume of the pipe

Therefore, **the dosing volume can be calculated by simply multiplying the linear feet percolation piping by 0.39.**

Example: A proposed system will have (7) 90' trenches (width of trench does not matter).
(7) (90) (0.39) = 246 gallon dosing volume

B. **Pumping Capacity**:

Based on 36 gpm per 1200 linear feet of percolation piping in the system.
This has been interpreted as follows:

If the system has 1200 linear feet of percolation piping or less:
The pump must provide a minimum of 36 gpm

If the system contains more than 1200 linear feet of percolation piping:
GPM = 36 x (linear feet of pipe / 1200)

Example: Determine the minimum required pumping capacity for a system that has (14) 100' trenches.
36 x (1400 / 1200) = 42 gpm
Keep in mind that you must also maintain a minimum force main velocity of 2 fps. If you are using a 2" force main (where 2 fps = 21 gpm) you are good to go. However, if using a 3" force main (for whatever reason) you would have to increase the gpm to 46.1 gpm (see section 1.B on the previous page) in order to satisfy the 2 fps requirement.

Total Dynamic Head (TDH)

In order to make a proper pump selection, the total dynamic head of the system must be calculated.

This is what the pump has to overcome to get the effluent from point A to point B

Total head is expressed in **feet of water**.

1 pound per square inch (psi) = 2.31 feet of water
(see page 9 to see the relationship between psi and feet of water)

A. **Static Head** (lift)

The difference in elevation from the discharge point to the "pump off" float (expressed in feet).

B. **Friction Head**

When liquid flows through a pipe it is impeded by resistance created by friction.

The rougher the inside of the pipe, the greater the friction
The greater the velocity of flow, the greater the friction
The smaller the diameter of pipe, the greater the friction

Use the Hazen-Williams Equation to calculate friction losses:

$f = (0.2083)\,(100/C)^{1.85}\,(Q^{1.852}/d^{4.8655})$
where,

f = friction head in feet of water per 100 feet of pipe
C = Hazem Williams Constant (roughness of pipe)
150 for new PVC pipe,
140 for older PVC pipe,
130 (use this if you wish to be very conservative)
Q = flow in gallons per minute
d = inside diameter of pipe, in inches

C. **Total Dynamic Head = Static Head + Friction Head**

Note: If dealing with a pressurized system (e.g. LPD, drip, etc.) you would also have to add pressure head.

Total Dynamic Head (TDH) Example

1. Static Head

A. Determine the static head when given an accurate site plan with elevations / topography. (See page 10 for example site plan)

The actual static head will be the elevation of the force main at the distribution box minus the elevation of the pump off float in the pump chamber. To estimate this consider the following.

Elevation at ground surface over proposed distribution box location	=	131'
Elevation of ground surface over proposed pump chamber location	=	104'
Difference	=	27'

The "pump off" float will be located approximately 4' below the top of the tank. Therefore, add another 4' of elevation for a total static head of 31'.

Note: This is assuming that the top of the pump chamber and the top of the distribution box will be roughly the same depth below the original ground surface. If this is not the case the static head will need to be adjusted.

When the system is installed the contractor should verify (before purchasing the pump) that there is no more than 31' of rise from the "pump off" float to the point of discharge.

B. Determine the static head when given a site plan with no elevations / topography. (See page 11 for example site plan)

In the field, measure the distance in a straight line from the proposed pump chamber to the proposed distribution box. From the example site plan this appears to be about 300'.

Next, record the slope from the proposed pump chamber to the proposed distribution box.
Note: This is NOT measured perpendicular to contour. It must be measured from the points described.

If you measured the slope in percent, it must be converted to degrees as follows:
Take the percent slope, divide by 100, and then, using a scientific calculator, press the Tan^{-1} key.

Assume that you measured a slope of 9% with your clinometer. Converted to degrees = 5.14

Determine the "lift" from the ground surface at the pump chamber to the ground surface at the distribution box:

= (sine of the slope in degrees) (distance along the slope)
= (sine 5.14) (300') =26.9' (say 27')

As above, the "pump off" float will be located about 4' below the top of the tank. Therefore, this Should be added to the static head: 27' + 4' = 31'

You could also use a shortcut conservative method:

Take the percent slope as measured above (9%), multiply by the distance measured (300'), and divide by 100 (don't forget to add depth to off float). This is not an exact measurement because you are using the hypotenuse as the run. This shortcut method will give you a conservative static head. This method should not be used when dealing with steep slopes or long pumping distances.

Total Dynamic Head (TDH) Example

2. Friction Head

First determine the "equivalent" length of pipe that will be used. This includes the length of the force main, bends, valves, etc. The friction encountered when water flows through a bend or a valve is equivalent to the friction encountered when flowing through a specified length of straight pipe. For example, the friction through a 2" 90 degree bend is equivalent to the friction through about 5.2' of straight 2" pipe. There are tables available that provide these "equivalent" lengths. Tables may vary to some degree. See page 12 for a sample table of "equivalent feet of pipe for various pipe fittings".

In the example it appears that the following will be needed (assume 2" pipe and 2" fittings):

Length of 2" pipe	= 350'
(4) 90 degree bends @ 5.2' each	= 21' +/-
(4) 45 degree bends @ 2.8' each	= 11' +/-
(1) 2" gate valve @ 1.4'	= 2' +/-
(1) 2" check valve @ 17.2'	= 17' +/-
Total "equivalent length of pipe	= 401'

Using the Hazen-Williams Equation, calculate the friction loss:

$$f = (0.2083)\ (100/C)^{1.85}\ (Q^{1.852}/d^{4.8655})$$

where,

- f = friction head in feet of water per 100 feet of pipe
- C = Hazem Williams Constant (roughness of pipe)
- Q = flow in gallons per minute
- d = inside diameter of pipe, in inches

We will use a C value of 150 for new PVC pipe.
We will first determine the friction loss at our minimum required pumping capacity of 21 GPM (Q).
The diameter of a 2" PVC pipe is 2.067".

$$f = (0.2083)\ (100/150)^{1.85}\ (21^{1.852}/2.067^{4.8655})$$
$$f = 0.81'$$

Remember, this is 0.81' of friction head per 100' of equivalent 2" pipe. Since we have 401' of equivalent pipe, we must multiply 0.81 by 4.01 (4.01 is 401/100).

Therefore, the total friction head at 21 gpm for this system is (0.81) (4.01) = 3.2'

Total Dynamic Head (TDH) Example

Determine the Total Dynamic Head in the example.

TDH = Static Head + Friction Head

TDH = 31' + 3.2' = **34.2' at 21 gpm**

In order to select a pump properly and to determine the "operating point of the pump a "system curve" should be calculated. To do this we must calculate friction losses at several different "Q" values (i.e. gpm) for this system. Use the Hazen-Williams Equation:

Static Head	+	Friction Head	=	TDH
31'	+	0' @ 0 gpm	=	31.0'
31'	+	0.8' @ 10 gpm	=	31.8'
31'	+	3.2' @ 21 gpm	=	34.2'
31'	+	6.3' @ 30 gpm	=	37.3'
31'	+	8.8' @ 36 gpm	=	39.8'
31'	+	13.3 @ 45 gpm	=	44.3'
31'	+	19.3 @ 55 gpm	=	50.3'
31'	+	26.3'@ 65 gpm	=	57.3'
31'	+	34.2'@ 75 gpm	=	65.2'
31'	+	42.2'@ 84 gpm	=	73.2'

Take a look at a sample pump performance curve (see page 14).

Graph these values on the pump performance curve chart. See page 15. This is the system curve. The pump will operate at the intersection of the pump curve and the system curve.
At the intersection move horizontally to the left to determine what the TDH will be and move vertically down to see how many gallons per minute a particular pump is capable of providing.

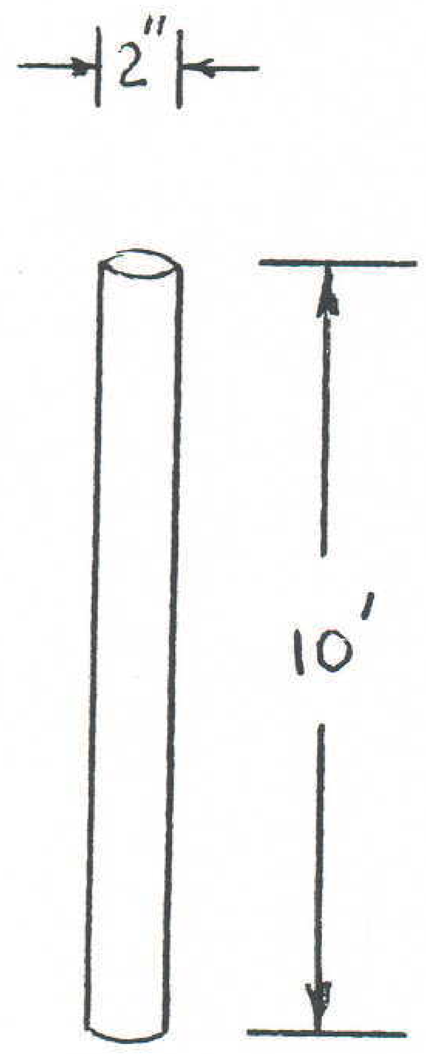
If your goal is to pump at least 21 gpm (i.e. 2 feet per second in a 2" force main) select a pump where the intersection of the system curve and pump curve exceeds 21 gpm.

If your goal is to pump at least 36 gpm (i.e. enhanced flow distribution) select a pump where the intersection of the system curve and pump curve exceeds 36 gpm.

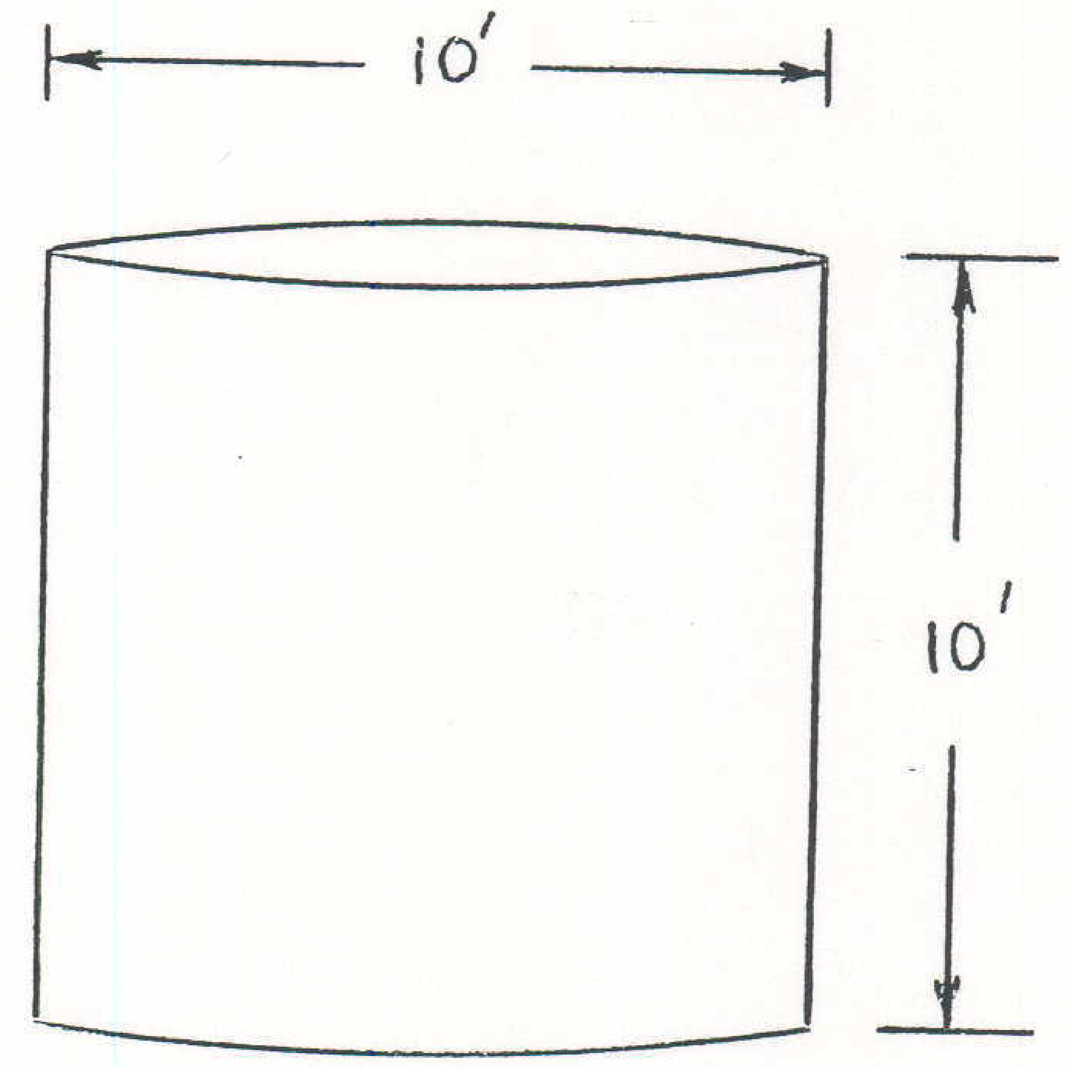
Also make sure that the point of intersection will not exceed 84 gpm (i.e. 8 feet per second in a 2" pipe).

PSI and "Feet of Water" (i.e. "Feet of Head")

1 psi = 2.31 feet of water
1 gallon of water weighs approximately 8.33 pounds
Calculate:
1. The psi at the base of a 2" pipe that is 10 feet long
2. The psi at the base of a 10' diameter tank that is 10 feet deep



1



2

First determine the volume in cubic inches

$V = \pi r^2 h$
$V = \pi(1")^2(120")$
$V = 377 \text{ in}^3$
Convert to gallons:
$377 \text{ in}^3 / 231 \text{ in}^3$ per gallon = 1.63 gallons
Convert gallons to pounds:
1.63 x 8.33 = **13.6 pounds**
Determine the number of square inches
at the base of the pipe:
$A = \pi r^2$
$A = \pi(1)^2$
A = **3.14 in^2**

13.6 pounds are above a 3.14 in^2 area.
Therefore, the pounds per square inch at the base = 13.6 / 3.14 = 4.33 psi

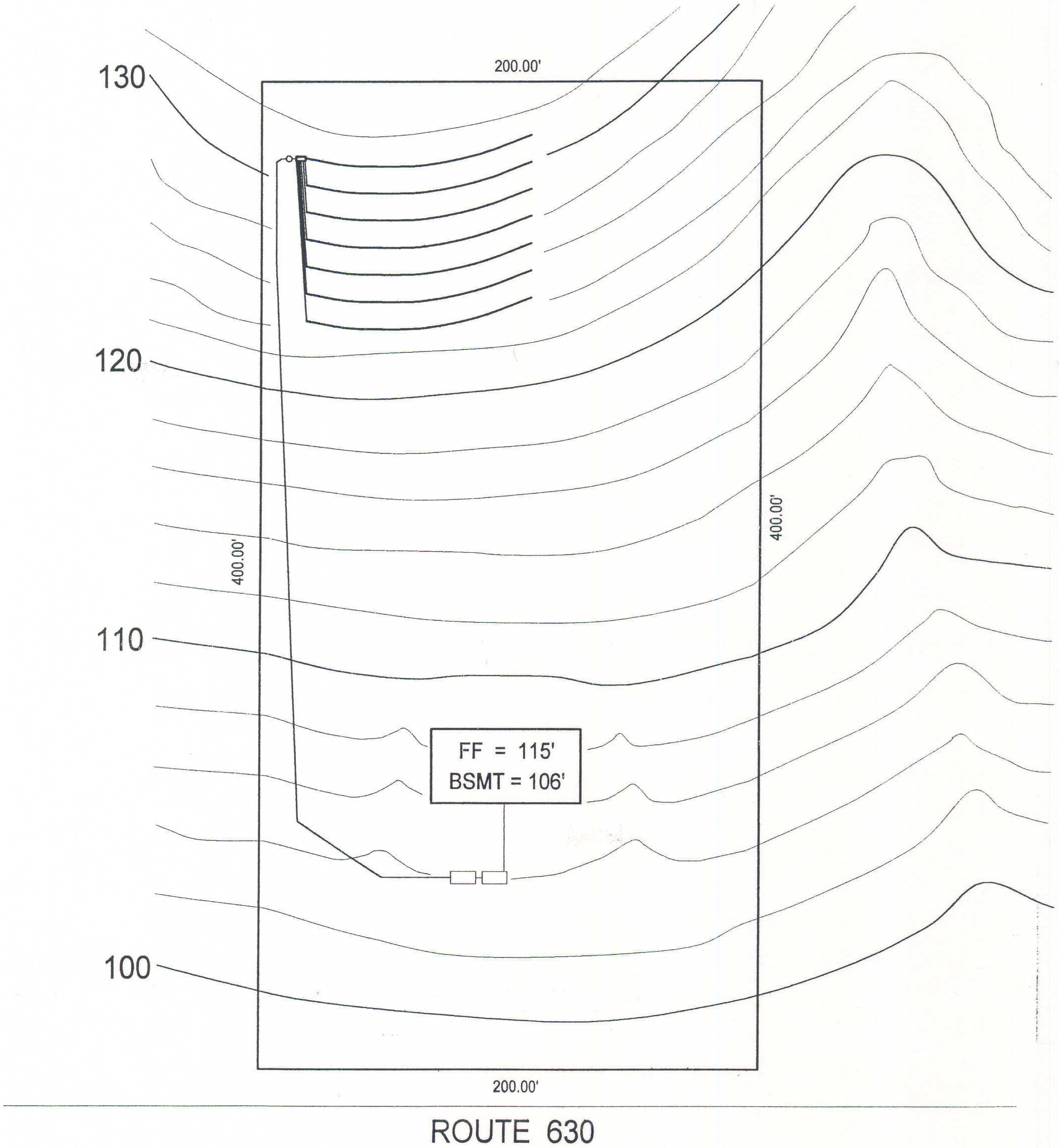
You can relate psi to feet of water:
4.33 psi = 10' (120") of water
10 / 4.33 = 2.31'
Therefore, 1 psi = 2.31' of water

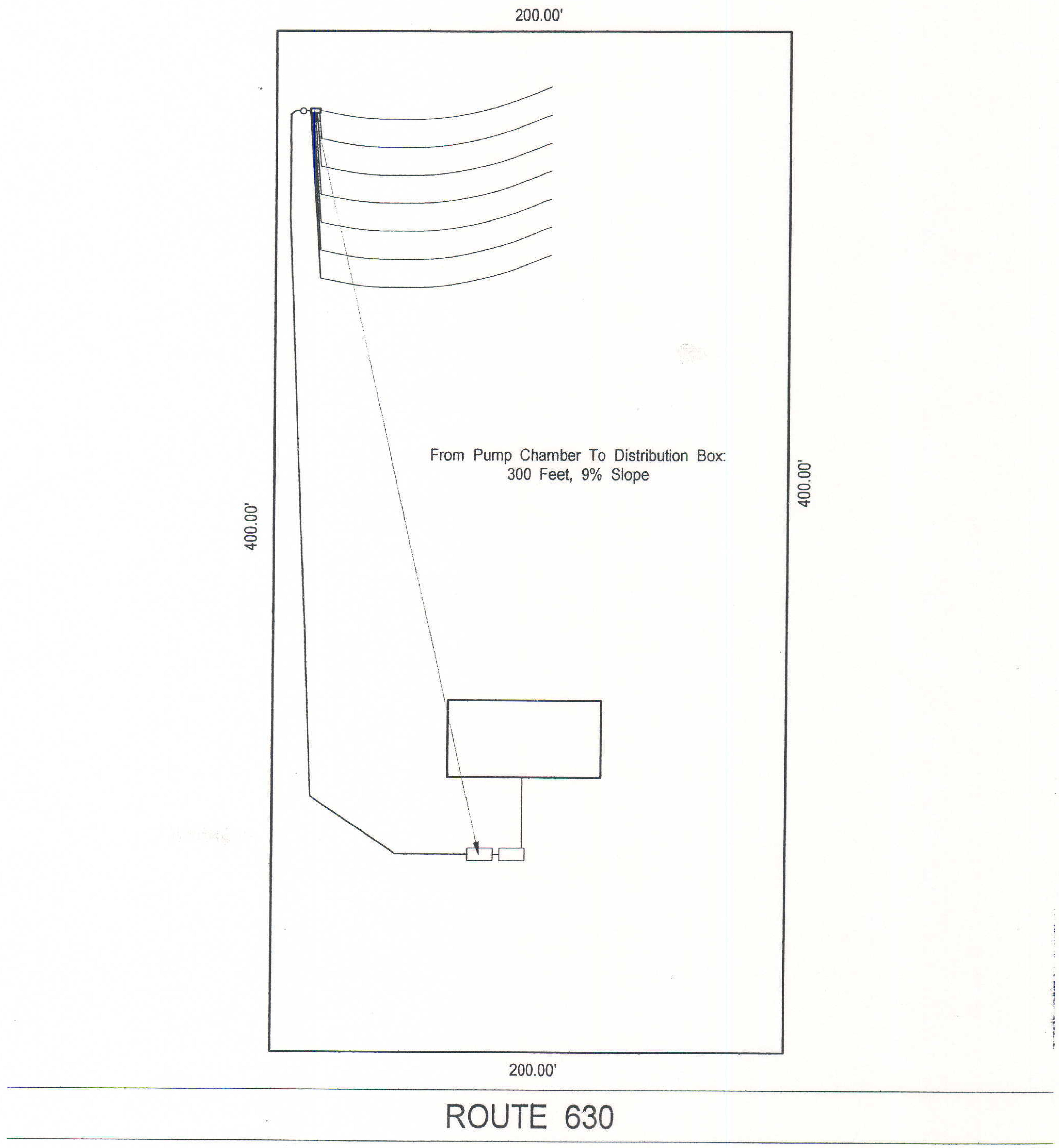
$V = \pi r^2 h$
$V = \pi(60")^2(120")$
$V = 1{,}357{,}168 \text{ in}^3$
Convert to gallons:
$1{,}357{,}168 \text{ in}^3 / 231 \text{ in}^3$ / gal = 5,875 gals
Convert gallons to pounds:
5,875 x 8.33 = **48,939 pounds**
Determine the number of square inches
at the base of the tank:
$A = \pi r^2$
$A = \pi(60)^2$
A = **11,310 in^2**

48,939 lbs. are above a 11,310 in^2 area.
Therefore, the pounds per square inch at the base = 48,939 / 11,310 = 4.33 psi

You can relate psi to feet of water:
4.33 psi = 10' (120") of water
10 / 4.33 = 2.31'
Therefore, 1 psi = 2.31' of water

In both examples, the pressure exerted at the base is 4.33 psi. This can be expressed as "10 feet of water" or "10 feet of head".


130
120
110
100
200.00'
400.00'
400.00'
FF = 115'
BSMT = 106'
200.00'
ROUTE 630


200.00'
From Pump Chamber To Distribution Box:
300 Feet, 9% Slope
400.00'
400.00'
200.00'
ROUTE 630

Equivalent Length (in feet) of Straight Pipe for Various Fittings

Nominal Pipe Size	90 Degree Bend	45 Degree Bend	Gate Valve	Check Valve
2"	5.2	2.8	1.4	17.2
2 1/2"	6.2	3.3	1.7	20.6
3"	7.7	4.1	2.0	25.5
4"	10.0	5.0	2.3	33.0

For additional fittings refer to a hydraulic handbook.

Total Dynamic Head (TDH) Calculation Worksheet

Static Head (H_s):

E_1 = _____ (Elevation of force main at distribution box)
E_2 = _____ (Elevation at pump off float)
$H_s = E_1 - E_2$
H_s = _____ - _____ = _____

Friction Head (H_f):

Based on Hazen-Williams Equation:

$f = (0.2083) \times (100/C)^{1.85} \times (Q^{1.852} / d^{4.8655})$

use: C = 150 (new PVC pipe)
Q = 21 GPM (2 fps in 2" pipe)
d = 2.067 (actual I.D. of 2" SCH. 40 PVC)

$f = (0.2083) \times (100/150)^{1.85} \times (21^{1.852} / 2.067^{4.8655})$

f = 0.81' (per 100' of equivalent length of 2" pipe)

Equivalent Length of 2" Pipe (L):

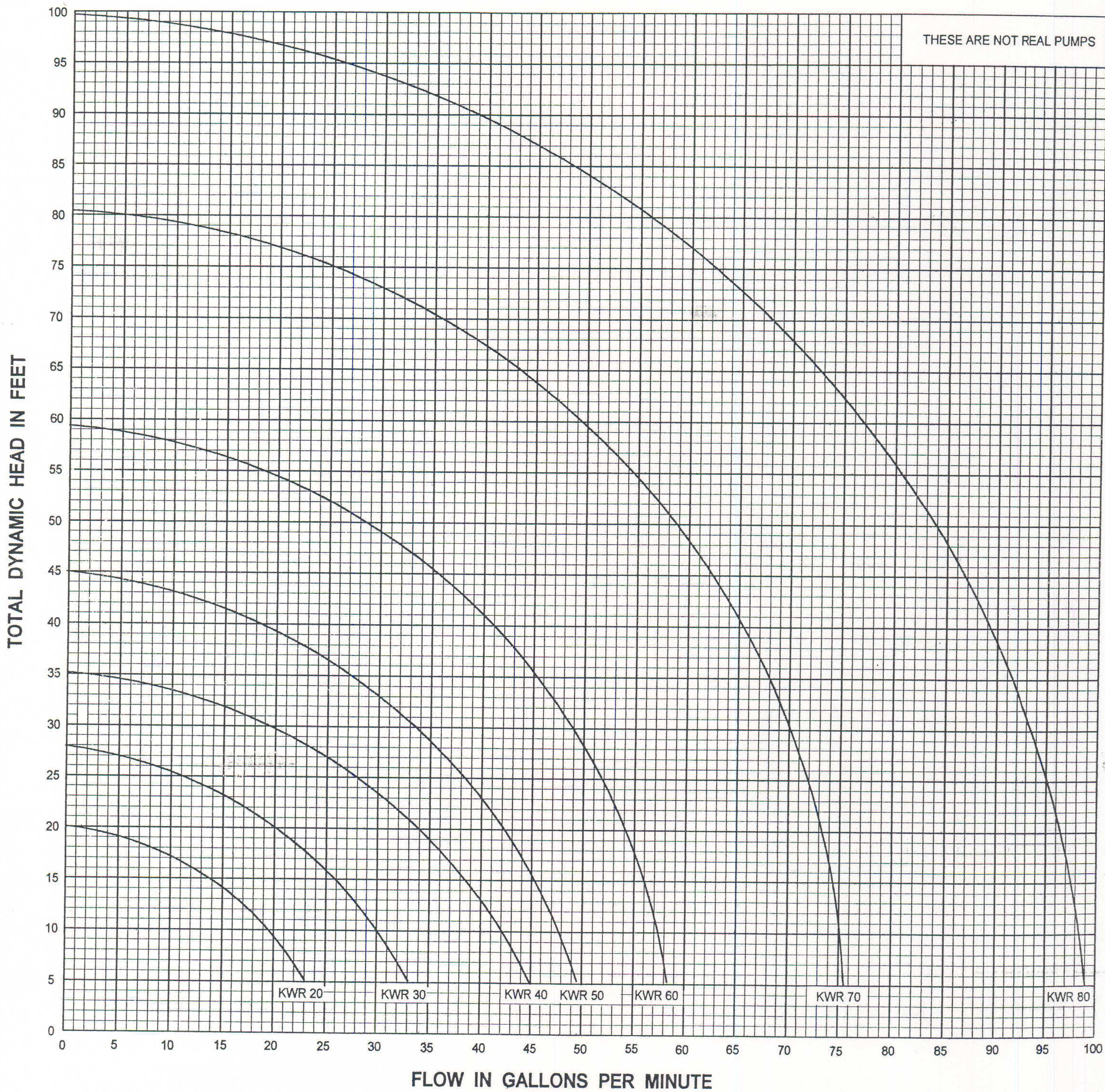
Length of 2" Pipe	= _______
2" 90 degree bends _____ x _____	= _______
2" 45 degree bends _____ x _____	= _______
2" Gate Valve	= _______
2" Check Valve	= _______
Total (L)	= _______

H_f = f x [(L)/100)]
H_f = 0.81' x _______ = _______

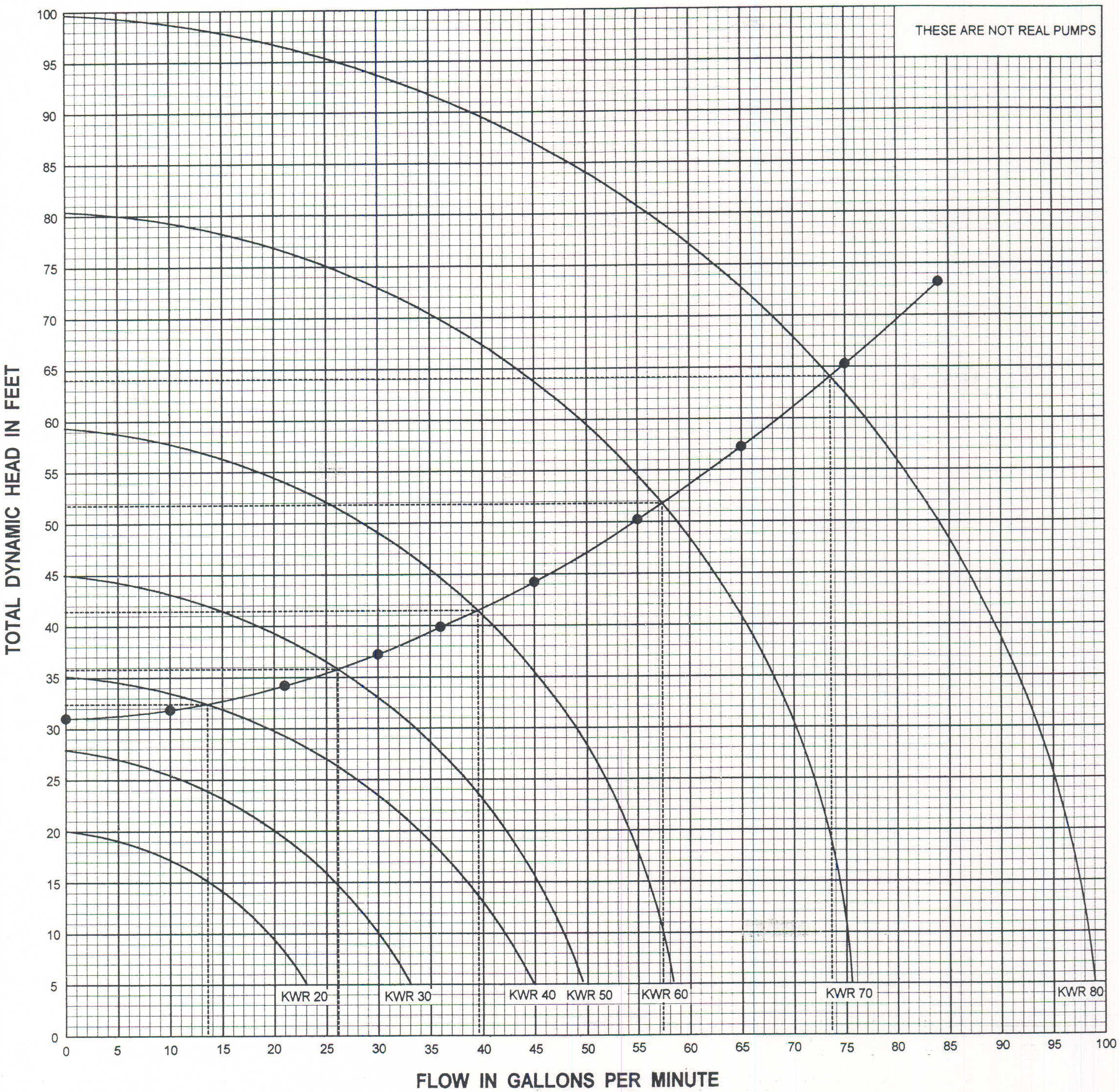
Total Dynamic Head (TDH):

TDH = H_s + H_f
TDH = _____ + _____ = _______

PUMP PERFORMANCE CURVES



PUMP PERFORMANCE CURVES

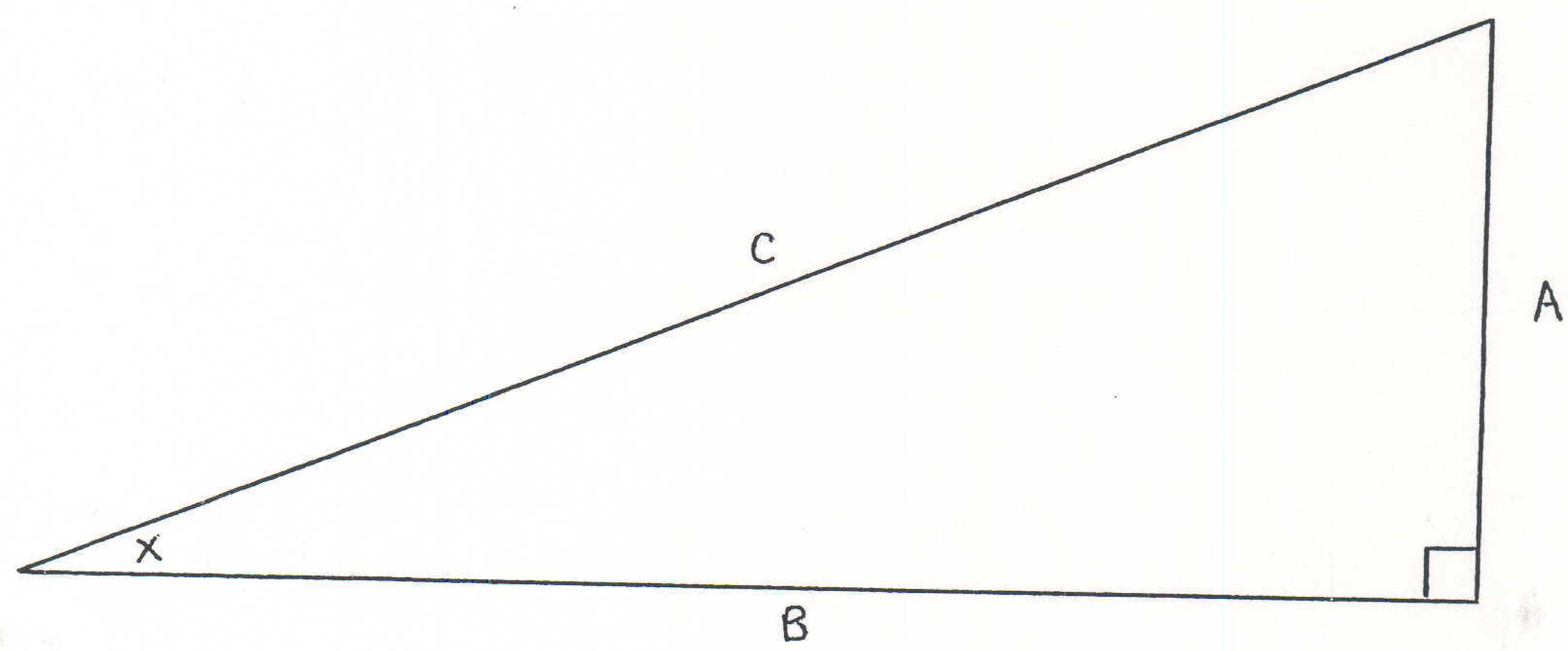


BLUE LINES = PUMP PERFORMANCE CURVES

RED LINE = EXAMPLE SYSTEM CURVE (based on 31' of static head and 401' of "equivalent length" of 2" pipe)

THE INTERSECTION OF THE BLUE LINES AND RED LINE
REPRESENTS THE OPERATING POINT FOR EACH PUMP

KWR 20 = WON'T WORK (SYSTEM CURVE DOES NOT INTERSECT PUMP CURVE)
KWR 30 = WON'T WORK (SYSTEM CURVE DOES NOT INTERSECT PUMP CURVE)
KWR 40 = 13.6 GPM (DOES NOT PROVIDE 2 FPS IN A 2" PIPE)
KWR 50 = 26.2 GPM (GOOD SELECTION IF 21 GPM MINIMUM IS OBJECTIVE)
KWR 60 = 39.6 GPM (GOOD SELECTION IF 36 GPM MINIMUM FOR ENHANCED FLOW IS OBJECTIVE)
KWR 70 = 57.3 GPM (OVERKILL)
KWR 80 = 73.6 GPM (OVERKILL AND IS APPROACHING 8 FPS IN 2" PIPE)



Sin of x (in degrees)	x	C (in feet)	=	A (in feet)
Cos of x (in degrees)	x	C (in feet)	=	B (in feet)
Tan of x (in degrees)	x	B (in feet)	=	A (in feet)

B (in feet) ÷ Cos of x (in degrees) = C (in feet)

SOH CAH TOA

Sin of the angle = **O**pposite side / **H**ypotenuse

Cos of the angle = **A**djacent side / **H**ypotenuse

Tan of the angle = **O**pposite side / **A**djacent side

To Convert Percent to Degrees:

Divide percent by 100 and then press the Tan^{-1} key on a scientific calculator.

Example: Convert 24% to degrees
(24/100), then press Tan^{-1} (arctangent key) on calculator
Answer is 13.5 degrees

WHAT YOU NEED TO KNOW TO FILL OUT A PERMIT PUMP PAGE

1. What **size pump chamber** should I use?
   Rule of thumb: If your combined ¼ day storage and your dose are less than 300 gallons, try a 750 gallon pump tank. If more than 300 gallons, **try a 1000 gallon pump tank**.

2. What is **¼ day storage**?
   This is the volume required between the high water alarm and 1" below the invert of the inlet.
   Example: 4 bedroom house @ 600 gpd
   ¼ day storage must be at least (1/4) (600) = 150 gallons
   How many inches would this be in a pump chamber?
   If using a 1000 gallon pump chamber:
   Many 1000 gallon pump chambers contain about 20 gallons per inch. Therefore, 150 gallons or storage would be equal to (150 gallons) / (20 gallons per inch) = 7.5"
   Learn the gallons per inch for the tanks in your area.

3. How much should the **drawdown** be **in gallons** (i.e. the gallons pumped to the drainfield each time the pump cycles)?
   It depends on your reason for pumping:
   a. If you are pumping simply to overcome elevation the regulations allow your dose to be ¼ to a full daily flow.
      Example: 4 bedroom house @ 600 gpd
      ¼ to a full daily flow would be 150 to 600 gallons per dose.
   b. If you are pumping for the purpose of enhanced flow distribution the regulations say that your dose must equal 60% of the volume of the percolation piping. This works out to be **(linear feet of trench) (0.39)**.
      Example: 4 bedroom house @ 600 gpd; proposed drainfield will have (7) trenches 90 feet long
      This gives you 630 linear feet of trench. Multiply by 0.39. Enhanced flow dose = 246 gallons
   - Most EHS's design their **drawdown** based on enhanced flow.

   How much should the **drawdown** be **in inches**?
   Take your dose in gallons and divide by the gallons per inch in your tank.
   Example: Use a 1000 gallon tank that contains 20 gallons per inch;
   use the enhanced flow dose above (246 gallons)
   (246 gallons) / (20 gallons per inch) = 12.3 inch drawdown

4. What should the **maximum pump run time** be?
   This will depend on the gallon per minute requirement:
   - If using a 1 ½" force main you must pump at a rate of at least 12.7 gpm to achieve the 2 feet per second requirement,
   - If using **a 2" force main** you must pump at a rate of at least 21.0 gpm to achieve the 2 feet per second requirement
   - If using a 3" force main you must pump at a rate of at least 46.1 gpm to achieve the 2 feet per second requirement

   If your pump page specifies a 2" force main (this is fairly standard) then your pump run time is determined as follows: **(proposed drawdown in gallons) / (21 gallons per minute).**
   In the example above (246 gallon dose) the maximum pump run time will be (246) / (21) = 11.7 minutes.
   Convert the decimal to seconds (i.e. 0.7 x 60) and you get 9 minutes, 42 seconds.

   If you are required to use enhanced flow (i.e. > 12 splits or reducing setback to stream) then your gallon per minute requirement will be different:
   For </= 1200 linear feet of trench you will have to use 36 gpm in the above equation (246/36 = 6 mins., 50 secs.)
   For > 1200 linear feet of trench you will calculate gpm as follows:
   (Linear feet of trench) / (1200) x (36),
   Example: If 1800 linear feet of trench are proposed, the gpm requirement would be (1800)/(1200) x 36 = 54 gpm
   Dose would be (1800) (0.39) = 702 gallons
   Pump run time would be (702) / (54) = 13 minutes maximum

Water Supply and/or Sewage Disposal System Construction Permit

Commonwealth of Virginia
Department of Health

______________________ Health Department

Health Department Identification Number ______________
Map Reference ______________

General Information

PAGE 1 OF

Water Supply System: New ____ Repair____ Public ____ FHA ____ VA ____ Case No. ____
Sewage Disposal System: New ____ Repair____ Expanded ____ Conditional ____ Public ____

Based on the application for a sewage disposal system construction permit filed in accordance with Section 2.13 E, of the Sewage Handling and Disposal Regulations and/or Section 2.13 of the Private Well Regulations a construction permit is hereby issued to:

Owner ______________________ Telephone ______________
Address ______________________ For a Type II Sewage Disposal System or Well to be constructed on/at ______________________
Subdivision ______________ Section/Block ________ Lot ________ Actual or estimated water use ________

DESIGN	NOTE: SEWAGE DISPOSAL SYSTEM INSPECTION RESULTS
Water supply, existing: (describe) ______________	**Water supply location:** Satisfactory yes ☐ no ☐ comments
To be installed: class ______________ cased ______________ grouted ______________	Completion Report G. W. 2 Received: yes ☐ no ☐ not applicable ☐
Building sewer: ______________ I.D. PVC Schedule 40, or equivalent. Slope 1.25" per 10' (minimum). ☐ Other ______________	**Building sewer:** Satisfactory yes ☐ no ☐ comments
Septic tank: Capacity ______________ gals. (minimum). ☐ Other ______________	**Pretreatment unit:** Satisfactory yes ☐ no ☐ comments
Inlet-outlet structure: PVC Schedule 40, 4" tees or equivalent. ☐ Other ______________	**Inlet-outlet structure:** Satisfactory yes ☐ no ☐ comments
Pump and pump station: No ☐ Yes ☒ describe and show design. if yes: See additional page(s)	**Pump & pump station:** Satisfactory yes ☐ no ☐ comments
Gravity mains: 3" or larger I.D., minimum 6" fall per 100', 1500 lb. crush strength or equivalent. ☒ Other 2" SCH. 40 PVC Pressure pipe w/pressure fittings	**Conveyance method:** Satisfactory yes ☐ no ☐ comments
Distribution box: Precast concrete with ________ ports. ☐ Other ______________	**Distribution box:** Satisfactory yes ☐ no ☐ comments
Header lines: Material: 4" I.D. 1500 lb. crush strength plastic or equivalent from distribution box to 2' into absorption trench. Slope 2" minimum. ☐ Other ______________	**Header lines:** Satisfactory yes ☐ no ☐ comments
Percolation lines: Gravity 4" plastic 1000 lb. per foot bearing load or equivalent, slope 2" 4" (min. max.) per 100'. ☐ Other ______________	**Percolation lines:** Satisfactory yes ☐ no ☐ comments
Absorption trenches: Square ft. required ________: depth from ground surface to bottom of trench ________; aggregate size ________: Trench bottom slope ______________; center to center spacing ________; trench width ________ Depth of aggregate ________; Trench length ________; Number of trenches ________	**Absorption trenches:** Satisfactory yes ☐ no ☐ comments Date ______________ Inspected and approved by: ______________ Sanitarian

C.H.S 202A

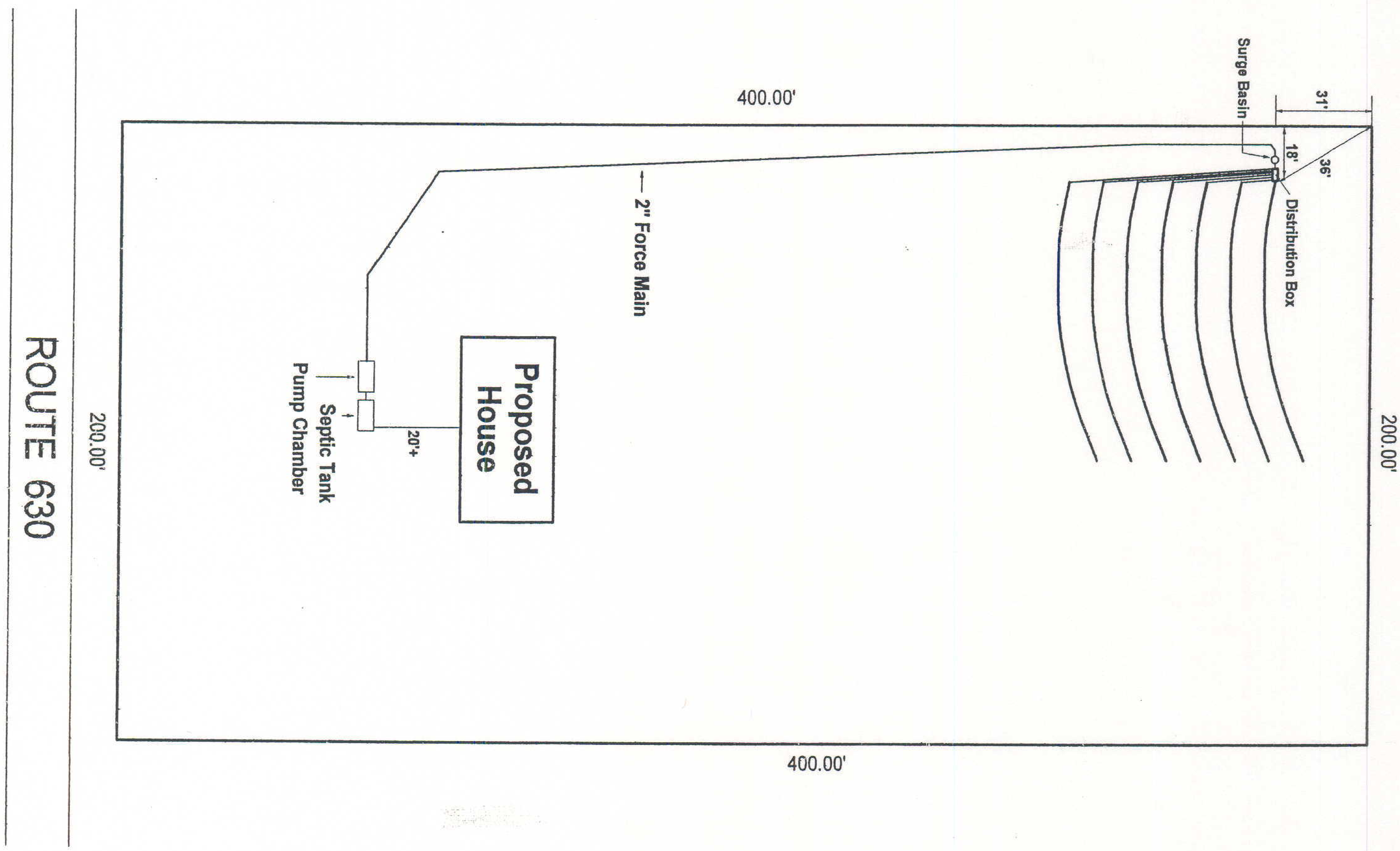
Health Department
Identification Number______

PAGE __ OF.

Schematic drawing of sewage disposal and/or water supply system and topographic features.

Show the lot lines of the building site, sketch of property showing any topographic features which may impact on the design of the well or sewage disposal system, including existing and/or proposed structures and sewage disposal systems and wells within 200 feet. The schematic drawing of the well site or area and/or sewage disposal system shall show sewer lines, pretreatment unit, pump station, conveyance system, and subsurface soil absorption system, reserve area, etc. When a nonpublic drinking water supply is to be permitted, show all sources of pollution within 200 feet.

☐ The information required above has been drawn on the attached copy of the sketch submitted with the application. Attach additional sheets as necessary to illustrate the design.



This sewage disposal system and/or water supply is to be constructed as specified by the permit X or attached plans and specifications______.

This sewage disposal system and/or well construction permit is null and void if (a) conditions are changed from those shown on the application (b) conditions are changed from those shown on the construction permit.

No part of any installation shall be covered or used until inspected, corrections made if necessary, and approved, by the local health department or unless expressly authorized by the local health dept. Any part of any installation which has been covered prior to approval shall be uncovered, if necessary, upon the direction of the Department.

Date: ______ **Issued by:** ______
Sanitarian

Date: ______ **Reviewed by:** ______
Supervisory Sanitarian

This Construction Permit Valid until ______

If FHA or VA financing

Reviewed by Date ______ ______ **Date** ______ ______
Supervisory Sanitarian Regional Sanitarian

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EHS Example

PUMP SYSTEM PLANS AND SPECIFICATIONS

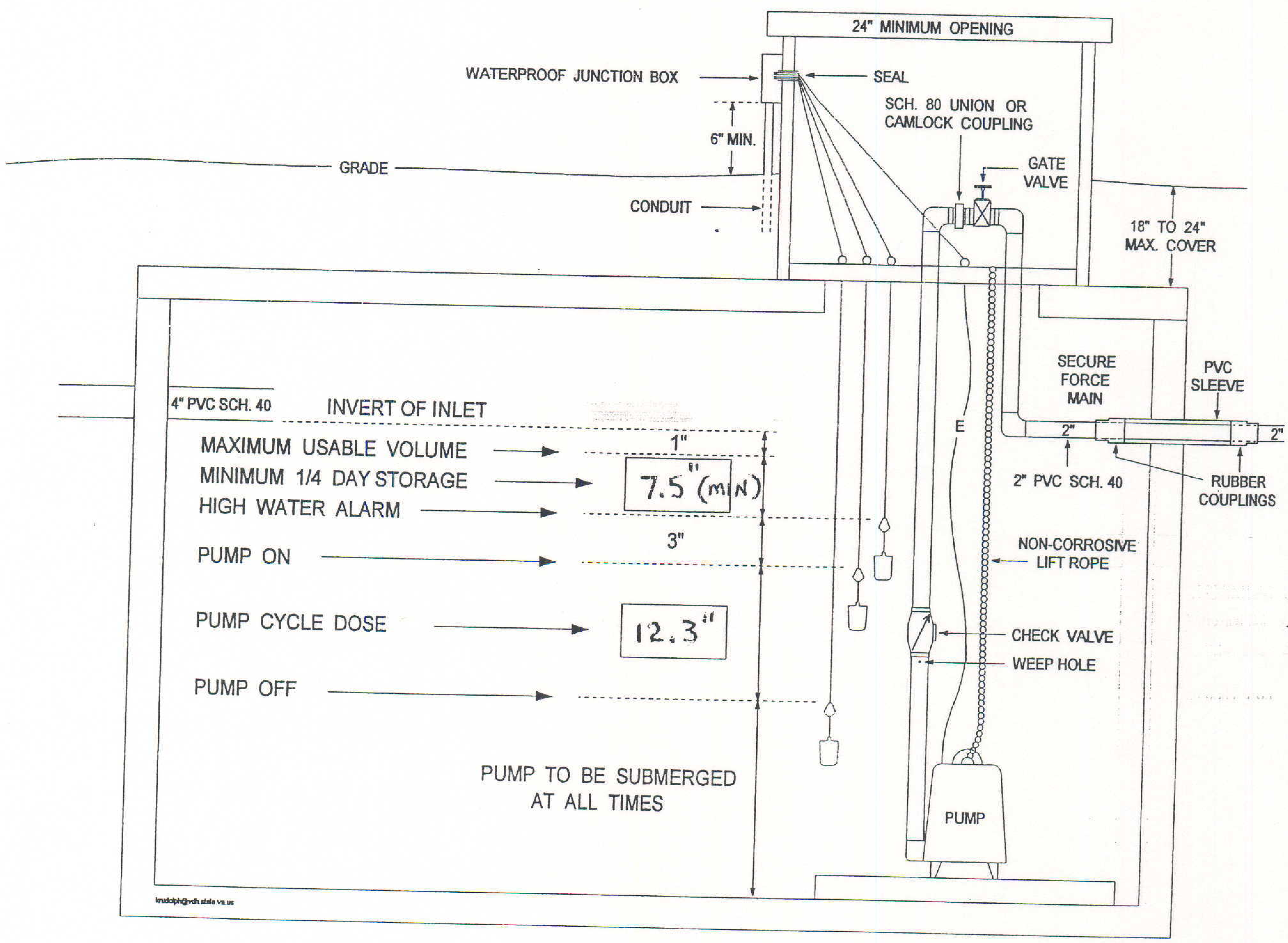
This example was based on enhanced flow distribution for a 4 bedroom dwelling with (7) 90'x3' trenches

Pump Chamber Size in Gallons	1000
Drawdown in Gallons (Each Pump Cycle)	246
Drawdown in Inches (Each Pump Cycle)	12.3

Force Main Shall be 2" Diameter SCH. 40 PVC Pressure Pipe with Pressure Fittings.
Pump Must Provide 36 Gallons per Minute Minimum and 84 Gallons per Minute Maximum at System Head.

Maximum Pump Cycle Time (Drawdown in Gallons / 36 GPM) = 6 mins., 50 secs.
Minimum Pump Cycle Time (Drawdown in Gallons / 84 GPM) = 2 mins., 56 secs.

Pump shall be of the open face centrifugal type designed to pump sewage.
The pump station must be provided with controls for automatically starting and stopping the pump based on water level.
The electrical motor control center and master disconnect switch shall be placed in a secure location above grade and remote from the pump station.
Each motor control center shall be provided with a manual override switch.
A high water alarm with remote sensing and electrical circuitry separate from the motor control center circuitry shall be provided.
The alarm shall be audiovisual and shall alarm in an area where it may be easily monitored.
All electrical connections shall be hardwired.
Do not use compression fittings.
Force main shall be deep enough to prevent freezing.
Pump chamber shall be level and watertight.



AOSE Example

PUMP SYSTEM PLANS AND SPECIFICATIONS

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Drawdown in Gallons (Each Pump Cycle) 246
Drawdown in Inches (Each Pump Cycle) 12.3

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All electrical connections shall be hardwired.
Do not use compression fittings.
Force main shall be deep enough to prevent freezing.
Pump chamber shall be level and watertight.

Static Head = 31.0'
Friction Head at 36 GPM = 8.8'
Total Dynamic Head at 36 GPM = 39.8'

This example based on 401' of "equivalent length" of 2" pipe.

Recommended Pump: KWR 60 (or equivalent)

See Pump Performance Curve Attached.
Operating point expected to be approx. 39.5 GPM